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ABSTRACT

Plans for permanent bleachers (consisting of five or more rows of seats) purchased and installed for use on K-12 athletic/play fields must be reviewed by the North Carolina Department of Public Instruction's (NCDPI) School Planning Section of the School Support Division. Bleachers may be purchased by local school boards as part of a regular new school, addition or renovation project, or stand-alone bleacher project, designed by a North Carolina licensed architect and/or engineer and submitted to School Planning for review in the normal process. They may also be purchased through the North Carolina Division of Purchase and Contract. School Planning is always required to review the plans. Structural designs for pre-engineered structures or systems used for school projects are often incomplete when bid documents are completed. Conditional certificates of review that allow mobilization and site preparation to begin prior to completion of final structural designs can be issued following review of bid documents. Project reviews are completed and certificates of review issued upon certification to School Planning that foundations and other structural systems have been designed or reviewed and approved by North Carolina registered structural engineers. This report presents NCDPI planning section recommendations, codes and design standards, NC Accessibility Code Volume I-C, and National Fire Protection Association requirements. (SM)

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OUTDOOR BLEACHERS

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OUTDOOR BLEACHERS

Plans for permanent bleachers purchased and installed for use on athletic/play fields at K-12 schools must be reviewed by the School Planning Section of the School Support Division of the North Carolina Department of Public Instruction per General Statute 115C-521. "Permanent Bleachers," for purposes of this article, shall be defined as any bleachers consisting of more than five rows of seats. Any configuration of five rows or less will be considered as "Portable Bleachers" and do not need to be submitted to School Planning for review.

Bleachers may be purchased by local school boards as a part of a regular new school, addition or renovation project, or a stand-alone bleacher project, designed by a North Carolina licensed architect and/or engineer and submitted to School Planning for review in the normal process. They may also be purchased through the North Carolina Division of Purchase and Contract(call 919-733-7325 for details for Purchase & Contracts procedures) and visit their website http://www.doa.state.nc.us/PandC/s5450-1.pdf.
In either scenario, School Planning is required to review the plans for permanent outdoor bleachers.

Structural designs for pre-engineered structures or systems used for school projects, such as grandstands or bleacher, are often incomplete when bid documents are completed, although general layouts and other information necessary to conduct architectural reviews are included. Conditional certificates of review that allow mobilization and site preparation to begin prior to completion of final structural designs can be issued following review of bid documents.

Project reviews are completed and certificates of review issued upon certification to School Planning that foundations and other structural systems have been designed by or reviewed and approved by North Carolina registered structural engineers for the projects. General Statute 133-1 requires that project architects and engineers be in the employ of owners and prohibits project designers being employed by or having financial interest in manufacturers or suppliers of pre-engineered structures

NCDPI, SCHOOL PLANNING SECTION RECOMMENDATIONS

1. Bleachers containing more than 5 rows shall be anchored to a continuous, leveled 4" minimum thickness concrete slab under the full footprint of the bleachers. The concrete shall be fc' = 3000 psi compressive strength and reinforced with 6x6w 2.9 x w2.9 welded wire fabric. The slab control joints and bleacher anchorage details shall be shown on the construction document and/or shop drawing.
2. Bleachers containing five rows or less shall sit on leveled "mud sills" at the support frame; not a continuous concrete slab within the footprint of the bleachers.
3. Provide lateral bracing in the support frames in both directions.
4. Where aluminum and steel are fastened together, provide neoprene pads to prevent contact and avoid the possibility of corrosion due to dissimilar metals reaction.
5. Early on, work with the local building inspector in securing approval of the bleacher construction.
6. For bleacher projects containing 1000 or more seats, the North Carolina Department of Insurance, Office of the State Fire Marshall must review and approve the plans.
7. Repair damaged hot-dipped galvanized coating with galvanized repair paint in accordance with ASTM A780 and manufacturer's written instructions.
8. Any field modifications to the bleachers shall be carried out under the supervision of the engineer of record.
9. Chain link fencing is a good choice for use as guards at the ends and backs of bleachers.
10. Minimum drawings for bleacher/grandstand projects for DPI, School Planning review:
    - site plan showing relationship to playfields, drives, walks, parking areas, other buildings and site improvements
    - plan showing seating layout, aisles, ramps, steps, railings, guards, handicapped seating cutouts, dimensions and relationships to adjacent site features and improvements
    - cross section through bleacher/stadium construction, showing all elements such as seat/foot boards, railings/guards, foundations, concrete slab under footprint, and other features needed to fully describe the project. Include dimensions such as riser height, row spacing, heights above grade, railing/guard heights, etc.
    - provide blow-up details of conditions as needed to describe project fully for construction documents for bidding purposes
    - bleacher/grandstand shop drawings produced by the successful bidder shall be submitted to DPI, School Planning for review as a final step in securing a "Certificate of Review" and completion of the review process

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CODES AND DESIGN STANDARDS

The following outline of various codes' and standards' requirements for bleachers/grandstands is not intended to be a complete and comprehensive list of what may be applicable to any bleachers/grandstands facility project. Instead, it is an attempt to highlight some of the major issues that will arise. Hopefully, this information will be helpful in the design process. Keep in mind, however, that codes and design standards may change over time.

N.C. State Building Code

1. Means of egress (section 1008 Assembly)
    - At least 0.3 inch of width for each occupant served shall be provided on stairs having risers heights 7 inches or less and tread depths 11 inches or greater, measured horizontally between tread nosing.
    - At least 0.005 inches of additional stair width for each occupant shall be provided for each 0.10 inch of riser height above 7 inches.
    - Where egress requires stair descent, at least 0.075 inches of additional width for each occupant shall be provided on those portions of stair width having no handrail within a horizontal distance of 30 inches.
    - Level or ramped means of egress, where slopes are not steeper than one unit vertical in 12 units horizontal (8.33% slope), shall have at least 0.20 inches of clear width for each occupant served.
    - Open-air seating: the travel distance from each seat to the exterior entrance(s) of the bleachers shall not exceed 400 feet measured along the aisle accessway and the aisle(s) without travel over the seats.
    - Every bleacher is required to have aisles leading to exits or exit access (refer to the N.C.S.B.C. for exceptions 1008.7).
        - **Exception**: An aisle is not required in seating facilities where all of the following conditions exist:
            1. Seats are without backrests.
            2. The rise from row to row does not exceed 6 inches per row.
            3. The row spacing does not exceed 28 inches unless the seat boards and footboards are at the same elevation.
            4. The number of rows does not exceed 16 rows in height.
            5. The first seating board is not more than 12 inches above the ground or floor below or a cross aisle.
            6. Seat boards have a continuous flat surface.
            7. Seat boards provide a walking surface with a minimum width of 11 inches.
            8. Egress from seating is not restricted by rails, guards or other obstructions.
    - Minimum aisle widths:
        - 48 inches for aisle stairs having seating on each side
            - Exception: 36 inches where aisle does not serve more than 50 seats
        - 36 inches for aisle stairs having seating on only one side
        - 23 inches between an aisle stair handrail or guard and seating where the aisle is subdivided by handrail
    - Each end of an aisle shall terminate at a cross aisle.
        - Dead-end aisles shall not exceed 20 feet in length.
        - Refer to 1008.7.5 for exceptions.
            - Dead-end aisles longer than 20 feet are permitted where seats beyond the 20-foot dead-end aisle are no more than 24 seats from another aisle, measured along a row of seats having a minimum clear width of 12 inches plus 0.6 inch for each additional seat above seven in the row.

- There shall be no obstructions in the required width of aisles except for handrails (described later).
- For rows of seating with aisles at both ends: 100 seats maximum per row
  - Minimum clear width of 12 inches between rows shall be increased by 0.3 inches for every additional seat beyond 14 seats, but minimal clear width is not required to exceed 22 inches.
  - Refer to table 1008.8.1 for exceptions.
- For rows of seating with an aisle only at one end:
  - Minimum clear width of 12 inches between rows shall be increased by 0.6 inches for every additional seat beyond 7 seat, but minimum clear width is not required to exceed 22 inches.
  - Path of egress travel shall not exceed 30 feet from any seat to a point where a choice of two paths of egress travel to two exits are available.
    - Where one of the two paths of travel is across the aisle through a row of seats to another aisle, there shall not be more than 24 seats between the two aisles.
    - Minimum clear width between rows for the row between the two aisles shall be 12 inches plus 0.6 inch for each additional seat above 7 in the row between aisles.
    - Refer to table 1008.8.1 for exceptions.
- Aisle stairs shall be provided with handrails located either at the side or within the aisle width.
  - Where there is seating on both sides of the aisle, the handrails shall be discontinuous with gaps or breaks at intervals not exceeding 5 rows.
  - These gaps or breaks shall have a clear width of 22 inches minimum.
  - Handrail shall have rounded terminations or bends.
  - Where handrails are provided in the middle of aisle stairs, there shall be an additional intermediate handrail located approximately 12 inches below the main handrail.
- Assembly guards (Section 1008.12):
  - Cross aisles located more than 30 inches above the floor or grade below shall have guards in accordance with Section 1003.2.12 as follows:
    - Guards shall be located along open-sided walking surfaces, stairways, ramps and landings that are located more than 30 inches above the floor or grade below.
    - Guards shall be adequate in strength and attachment in accordance with Section 1607.7.
    - Exception: Guards are not required for assembly seating where guards in accordance with Section 1008.12 are permitted and provided.
    - Guards shall form a protective barrier not less than 42 inches high, measured vertically above the leading edge of the tread adjacent walking surface or adjacent seatboard.
    - Open guards shall have balusters or ornamental patterns such that a 4 inch diameter sphere cannot pass through any opening up to a height of 34 inches. From a height of 34 inches to 42 inches above the adjacent walking surfaces, a sphere 8 inches in diameter shall not pass.
      - Exception: the triangular openings formed by the riser, tread and bottom rail at the open side of a stairway shall be such that a sphere of 6 inches in diameter cannot pass through.
  - Where an elevation change of 30 inches or less occurs between a cross aisle and the adjacent floor or grade below, guards not less than 26 inches above the aisle floor shall be provided.
  - Sightline – constrained guard heights (Section 1008.12.2)
    - Unless subject to the requirements of Section 1008.12.3, a railing system in accordance with Section 1003.2.12 and having a minimum height of 26 inches shall be provided where the floor or footboard elevation is more than 30 inches above the grade below and the railing would otherwise interfere with the sitelines of immediately adjacent seating.
  - Guards at the end of aisles (Section 1008.12.3.)

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- A railing system complying with the guard requirements of Section 1003.2.12 shall be provided for the full width of the aisle where the foot of the aisle is more than 30 inches above the grade below. The railing shall be a minimum of 36 inches high and shall provide a minimum 42 inches measured diagonally between the top of the rail and the nosing of the nearest tread.

- Bleacher footboards (Section 1008.13):
  - Bleacher footboards shall be provided for rows of seats above the third row or at such a point where the seating plank is more than 24 inches above the ground.
  - When projected on a horizontal plane, horizontal gaps shall not exceed 0.25 inches between footboards and seatboards.
  - At aisles, horizontal gaps shall not exceed 0.25 inches between footboards.
  - Where footboards are more than 30 inches above grade, openings between the seat and footboards shall not allow the passage of a sphere greater than 4 inches.
- Bench seating (Section 1008.14):
  - Where bench seating is used, the number of persons shall be based on one person for each 18 inches of length of the bench.

2. Structural Design (Chapter 16, also see NFPA 102):
   - Bleachers and grandstands shall be designed in accordance with Chapter 16.
   - Minimum uniformly distributed live loads (Table 1607.1):

     Bleachers: 100 Psf

     In addition to the vertical live loads, horizontal swaying forces parallel and normal to the length of seats shall be included in the design according to the requirements of Chapter 4 of NFPA 102.

   - Loads on handrails and guards (Section 1607.7):

     1607.7.1 **Handrails and guards**. Handrail assemblies and guards shall be designed to resist a load of 50 pounds per linear foot (pound per foot) (0.73 kN/m) applied in any direction at the top and to transfer this load through the supports to the structure.

     1697.7.1.1 **Concentrated load.** Handrail assemblies and guards shall be able to resist a single concentrated load of 200 pounds (0.89 kN), applied in any direction at any point along the top, and have attachment devices and supporting structure to transfer this loading to appropriate structural elements of the building. This load need not be assumed to act concurrently with the loads specified in the preceding paragraph.

     1607.7.1.2 **Components**. Intermediate rails (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds (0.22 kN) on an area not to exceed 1 square foot (305 mm2) including openings and space between rails. Reactions due to this loading are not required to be superimposed with those of either preceding paragraph.

     1607.7.1.3 **Stress increase.** Where handrails and guards are designed in accordance with the provisions for allowable stress design (working stress design) exclusively for the loads specified in Section 1607.7.1, the allowable stress for the members and their attachments are permitted to be increased by one-third.

NC ACCESSIBILITY CODE VOLUME I-C

- The North Carolina Accessibility Code 1999 requires the following minimum wheelchair seating for bleachers:

TOTAL SEATING CAPACITY IN ASSEMBLY AREAS	MINIMUM NUMBER OF REQUIRED WHEELCHAIR SEATING LOCATIONS
4 to 25	1
26 to 50	2
51 to 300	4
301 to 500	6
501 or more	6 plus 1 additional space for each total seating capacity increase of 100

One companion seat adjacent each wheelchair seat is required.

- Where bleachers are raised on a platform requiring a ramp for handicapped accessibility, the ramps must occur at both ends. (One end having steps only is prohibited.) It is recommended that steps and ramps be provided at both ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 102:

Chapter 4 Grandstands and Bleachers

- The depth of footboards and seat boards in grandstands shall be not less than 9"
- Any opening between the seatboard and footboard that is located more than 30 inches above grade shall be provided with intermediate construction such that a 4 inch diameter sphere cannot pass through.
- Railings or guards not less than 42 inches high above the aisle surface or footrest, or 42" vertically above the center of the seatboard surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all grandstands where the seats are more than 4 feet above the ground.
- Where the front footrest of any grandstand is more than 2 feet above the ground, railings or guards not less than 26 inches high above such front footrests shall be provided.
- Each cross aisle located at the front of the grandstand shall be provided with a rail not less than 36" high.
  - Exception: Railings at the foot of aisles where steps occur shall be not less than 42" high for the width of the aisle.
- Each cross aisle other than those located at the front of the grandstand shall be provided with a rail not less than 26" high.
- Vertical openings between guardrails and footboards or seatboards shall prevent the passage of a 4-inch diameter sphere.
- Spaces underneath a grandstand or bleacher shall be kept free of flammable or combustible materials.
  - Exceptions: Ticket booths, toilet facilities or concession booths of non-combustible or fire-resistive construction shall be permitted in such spaces.
- Structural design:

  NFPA-4-3.4 A grandstand shall be designed and assembled so that the maximum expansion, contraction, settlement, or misalignment likely to occur will not cause stresses in excess of those permissible nor jeopardize the structure or its occupants. It shall be designed to remain stable so as not to be overturned either by wind or unequal distribution of live load.

  NFPA-4-3.5 Design Loads:

  NFAP-4-3.5.1 Grandstands shall be designed to support, in addition to their own weight and the weight of added accessories, a uniformly distributed live load of not less than 100 lb/sf (488 kg/m2) of gross horizontal projection.

  NFPA-4-3.5.2 All seat board and footboard members shall be designed for a live load of not less than 120 lb/linear ft (179 kg/linear m).

  NFPA-4-3.5.3 Grandstands shall be designed to resist a horizontal swaying force applied to the seats, in a direction parallel to the length of the seats, of 24 lb/linear ft (36 kg/linear m) of seats and, in a direction perpendicular to the length of the seats, of 10 lb/linear ft (15 kg/linear m)of seats.

  NFPA-4-3.5.4 Wind Loads:

  NFPA-4-3.5.4.1 Grandstands shall be designed to withstand, with or without live loads, the horizontal and uplift pressures due to wind. Wind pressures shall be derived from ASCE 7, *Minimum Design Loads in Buildings and Other Structures.*

NFPA-4-3.5.4.2 Horizontal pressures shall be assumed to be acting on the gross vertical projection of the grandstand measured above the average level of the adjoining ground.

NFPA-4-3.5.4.3 Uplift wind pressures equal in magnitude to those shown in ASCE 7, *Minimum Design Loads in Buildings and Other Structures,* shall be assumed to be acting vertically on the gross horizontal projection of "closed deck" grandstands, the understructure of which is unenclosed. Uplift wind pressures equal to 60 percent of these values shall be assumed to be acting vertically on the gross horizontal projection of "closed deck" grandstands, the understructure of which is enclosed at the perimeter with solid walls.

NFPA-4-3.5.4.4 Uplift wind pressures equal to 1 ¼ times those shown in ASCE 7, *Minimum Design Loads in Buildings and Other Structures,* shall be assumed to be acting normal to an unenclosed roof situated over a grandstand.

NFPA-4-3.5.5 Handrails on grandstands shall be designed and constructed for:

(a) A concentrated load of 200 lb (91kg) applied at any point and in any direction, and
(b) A uniform load of 50 lb/ft (74 kg/m) applied in any direction.
The concentrated and uniform loading conditions shall not be required to be applied simultaneously.

NFPA-4-3.5.6 Guards of grandstands shall be designed and constructed for:

(a) A concentrated load of 200 lb (91kg) applied at any point and in any direction along the top railing member, and
(b) A uniform load of 50 lb/ft (74 kgm) applied horizontally at the required guardrail height and a simultaneous uniform load of 100 lb/ft (149 kgm) applied vertically downward at the top of the guardrail. The concentrated and uniform loading conditions shall not be required to be applied simultaneously.

NFPA-4-3.5.7 Each of the horizontal forces in 403.5.3, 403.5.5 and 403.5.6 shall not be required to be applied simultaneously with other lateral forces such as wind or seismic loads.

NFPA-4-3.6 Members in which the stresses are greater under a partial loading of the grandstand than under a full load shall be designed to meet the conditions causing the largest stress.

NFPA-4.3.7 Stresses permitted in the design standards of the various materials shall be permitted to be increased by 33 1/3 percent due to sway or wind loads or by a combination of sway or wind loads and vertical loads, provided that no such increases shall be allowed for stresses due to vertical loads acting alone.

NFPA-4-3.8 Foundations for permanent grandstands shall be designed to sustain a total load equal to the dead load plus 60 percent of the total of the live load and the transmitted wind or sway load.

ADDITIONAL RESOURCES

"Guidelines for Retrofitting Bleachers," U. S. Consumer Products Safety Commission.

(available on School Planning's website: www.schoolclearinghouse.org)

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